running mode and are saved as '*.raw*' format. The IMRT beams are delivered in Step and Shoot mode and for each of them a variable number of raw-images are saved (N_{raw}). The 'MatImrt-QA' perform the sum of the N_{raw} images in order to obtain a matrix giving the integral image. Integral image is corrected by offset, gain and defective pixels and than g-index of the fluence is calculated.

Results: The EPID has been characterized in terms of Monitor Units (MU), field size and dose-rate dependence. The integral signal, in pixel value (PV), varies linearly with MU and the plot is a line with 4,207 x 10^3PV/MU slope. The PV to field size dependence is represented by a biexponential function. The EPID response to dose-rate variation show a series of light and dark bands that disappear at dose rate increasing. In order to define the EPID water equivalent depth, beam profiles exported at different depths from treatment planning system (TPS) have been matched with EPID acquired ones. The best fit between EPID and TPS profiles is fixed at 150 mm depth. 60 IMRT beams have been verified evaluating the g-index with 'MatImrt-QA', the results have been compared with g-index calculated by 'I'mRT-QA' and the differences show a mean value of 0,26%±2%. The 'MatImrt-QA' perform EPID-TPS absolute dose matrices comparison too. By using the calibration factor calculated for EPID images (4,207 x 10^3PV/MU) we can convert fluence matrix into dose matrix and calculate the g-index with the TPS dose matrix.

Conclusions: The 'MatImrt-QA' accuracy and reliability have been tested, the use of EPID in pre-treatment verification for IMRT plans delivery should be improved for dose matrix checks when some acquisition parameters will be editable by the user and not fixed by the machine manufacturer.

EP-1556

Evaluation of IMRT skin flash planning techniques for abdominal and pelvic sarcomas

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Purpose/Objective: Some abdominal and pelvic sarcomas approach the skin surface so that the PTV extends outside the body to account for patient movement and set-up errors. When planning such an IMRT treatment, beam fluences should be extended to cover the PTV near the skin and beyond the body contour. This study investigates several techniques aimed at extending the dose in the skin flash region with IMRT.

Materials and Methods: Three IMRT plans of sarcomas were optimised with 4 planning techniques using:

1) Original PTV
2) PTV edited 5mm back from skin
3) PTV edited 5mm back from skin and for 2 fields, fluences extended using Eclipse TPS 'skin flash' tool (figure 1a)
4) Virtual bolus added for optimisation and removed to calculate the plan [1].

For each plan, the dose extension in the flash area was evaluated in the TPS. The target volume coverage was assessed for the following cases:

a) Perfect set-up
b) Set-up error, simulated by shifting the isocentre [1]
c) Distension of the abdomen simulated by adding a bolus.

The CTV coverage was assessed for cases a and b. For case c, the CTV position could have moved as a result of the distension. Hence, the PTV was more representative of the CTV position and the PTV coverage was measured instead. The average coverage for all three situations was also calculated.

An experimental assessment of the dose extension by the different IMRT techniques was performed. Plans were created for all techniques on a CIRS Head and Neck phantom (002HN) and doses measured using coronal EBT2 GafChromic® film and surface TLDs.

Results: The plans created with the first planning technique were not clinically acceptable as the maximum PTV dose far exceeded 107% of the prescribed dose (see table 1). This was expected, as the optimizer aimed to deliver the prescribed dose to the build up region and to air.

Techniques 2, 3 and 4 gave similar results for 2 patients. For the third patient, the virtual bolus technique undercovered the PTV and the fluence extension gave unacceptable hot spots.

Planning technique	Evaluation method	Patient 1	Patient 2	Patient 3
1) Original PTV	Max dose	214%*	148%*	171%*
2) Edited PTV	Average coverage	94.5%	96.3%	95.0%
3) Extension of fluences (*skin flash tool*)		94.6%	98.0%*	94.5%
4) Virtual bolus		94.6%	92.5%	94.9%

* *not clinically acceptable due to hot spots*

Table 1: evaluation of the dose extension in the skin flash area for 4 planning techniques

The experimental delivery of plans demonstrated the extension of the dose in the skin flash area when using the virtual bolus or the fluence extension techniques (see figure 1). However, TLD showed an increased surface dose of 8%, 29% and 34% for the set-ups a, b and c respectively when using the virtual bolus compared to the fluence extension technique.

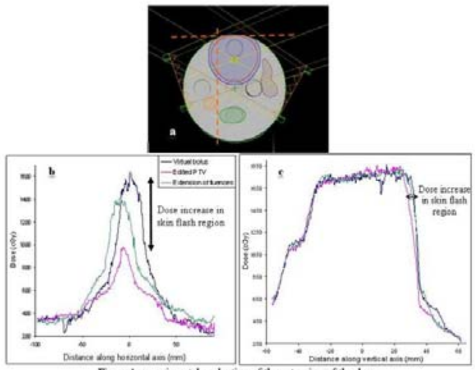

Figure 1: experimental evaluation of the extension of the dose.
1a shows a CTV (red), a PTV (blue), OAR outlined on a phantom and the dose profiles locations (orange).
1b and c: comparison of horizontal and vertical dose profiles in the skin flash area for the plans created using 3 planning techniques and assessed in the case of a set-up error.

Conclusions: The dose is not extended to cover the PTV near the skin and beyond the body contour when using the edited PTV IMRT technique. This study showed that two techniques are available to extend the dose in the skin flash area: the use of a virtual bolus and the extension of fluences. The Eclipse skin flash tool is parameter and user-dependant so the virtual bolus technique is more robust but it may increase the skin dose.

[1] Thomas et al. 'The effect of optimization on surface dose in intensity modulated radiotherapy (IMRT)', *PMB*, 49, 21, 2014.

EP-1557

Position and dose ñ end-to-end test audit phantom for stereotactic radiotherapy

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Purpose/Objective: As stereotactic radiotherapy becomes part of the clinical routine in more and more centres, the need for audit procedures and tools increases. Any audit of stereotactic radiotherapy should address position and delivered dose with equal importance. At the same time, measurement of dose in small stereotactic fields necessitates fine positioning of the probe. Preferably an audit should be uncomplicated and fast to perform. Considering those requirements, a new audit tool is presented, which allows audits to be performed efficiently either by an onsite team or as a postal audit.

Materials and Methods: A Stereotactic Cube phantom has been designed to perform Winston Lutz type position verification measurements and dose measurements in one setup. The phantom comprises a plastic cube with a high density ball in its centre, low density spheres in the periphery, strategically placed gold markers near the posterior and right surfaces and slit-like openings to insert film or other detectors for dose measurement. For the end to end procedure the phantom is first scanned. A treatment plan is created with dose delivered to one or both of the measurement locations using small fields. The fields do not traverse any of the high or low density material. The phantom is setup at the delivery system using 3D imaging. Film has been attached to the phantom at two locations and an orthogonal pair of static beams is delivered for position verification. The exposed films show shadows of the centre ball and the other high density markers. Based on the position of the centre marker on the images relative to the field dimension and to the other markers, the alignment of the phantom in all six dimensions can be verified using image analysis of the scanned films. Alternatively these images can be collected with an MV EPID. Dose measurements are performed with either an ionization chamber or solid state detector, which would have been in place during alignment, or with film, which is inserted into the phantom just prior to exposure.

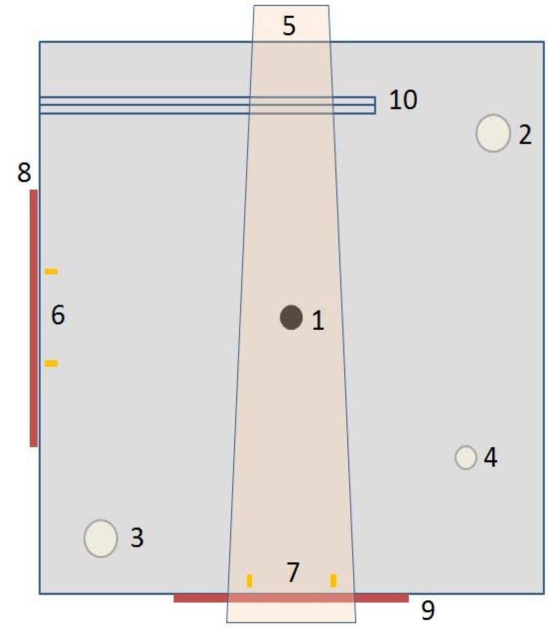

Figure: Axial cut view: high density ball at centre (1), low density objects for kV CBCT alignment in periphery (2-4), simulated beam (5), gold markers (6, 7) to show rotational alignment in MV imaging on film (8, 9) or EPID (not shown) . Insert for dose measurement (10 – film option shown).

Results: Measurements with a prototype of the cube showed excellent suitability for cone beam computed tomography (CBCT) 3D alignment. While high density markers naturally degrade CBCT images through artefacts, the position and good visibility of the low density markers allowed for robust alignment of the cube. MV imaging with film and EPID allowed for clear identification of all markers. Dose measurements were performed with film, while the insert for a small ion chamber is still under construction.

Conclusions: A phantom and methods for an uncomplicated stereotactic audit considering position and dose have been developed and tested.

EP-1558

Adapting the AAPM TG 119 to VMAT treatments and a volumetric phantom

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Purpose/Objective: A treatment planning system (TPS) should be verified in a real 3D situation with rigorous procedures, both for static and rotational modulated techniques. The American Association of Physicists in Medicine Task Group 119 (TG119) proposed a water equivalent square slab phantom (30x30x15 cm^3) with four IMRT tests: Mock Prostate, Head-and-Neck, C-shaped target, and Multi Target. Each test was developed to assess the overall accuracy of planning and delivery of IMRT treatments. TG119 defines also beam arrangements, goals, and methods to analyze dosimetric results. The AAPM phantom is cheap and easily reproducible in every department, but it allows only single point or single planar measurements. In this work